Extending CMMI to Hardware Engineering Disciplines

NDIA System Engineering Conference
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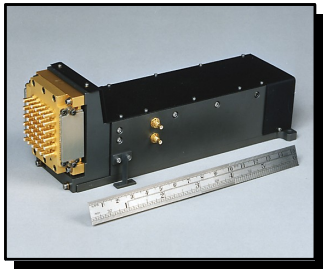
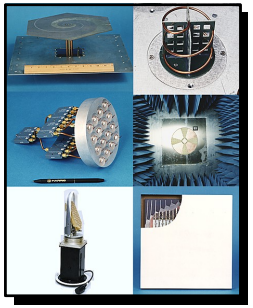
- **Extending CMMI to Hardware Engineering Disciplines**
  - **Application context**
  - **Process improvement infrastructure**
  - **Hardware process improvement objectives**
  - **Improvement approach**
  - **Metrics**
  - **Lessons Learned**
  - **Summary**

Hardware Application Context

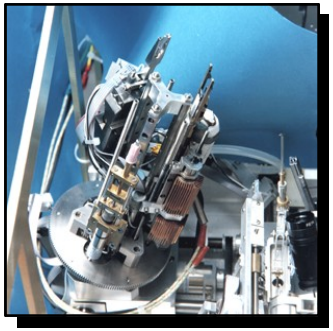


OPTICAL PROCESSING

LEADING EDGE TECHNOLOGIES → MISSION KNOWLEDGE

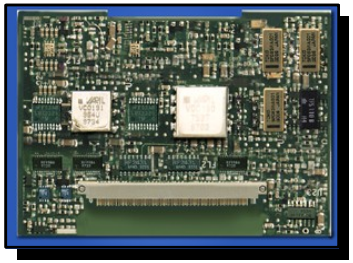


SPECIALIZED ANTENNAS

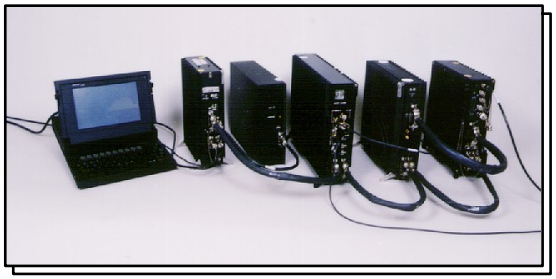


PRECISION ROBOTICS

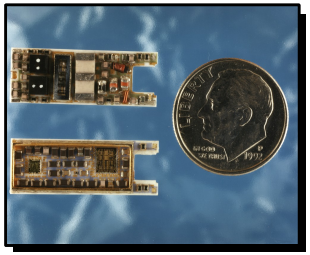
SYSTEM COMMAND & CONTROL



ADVANCED SIGNAL PROCESSING



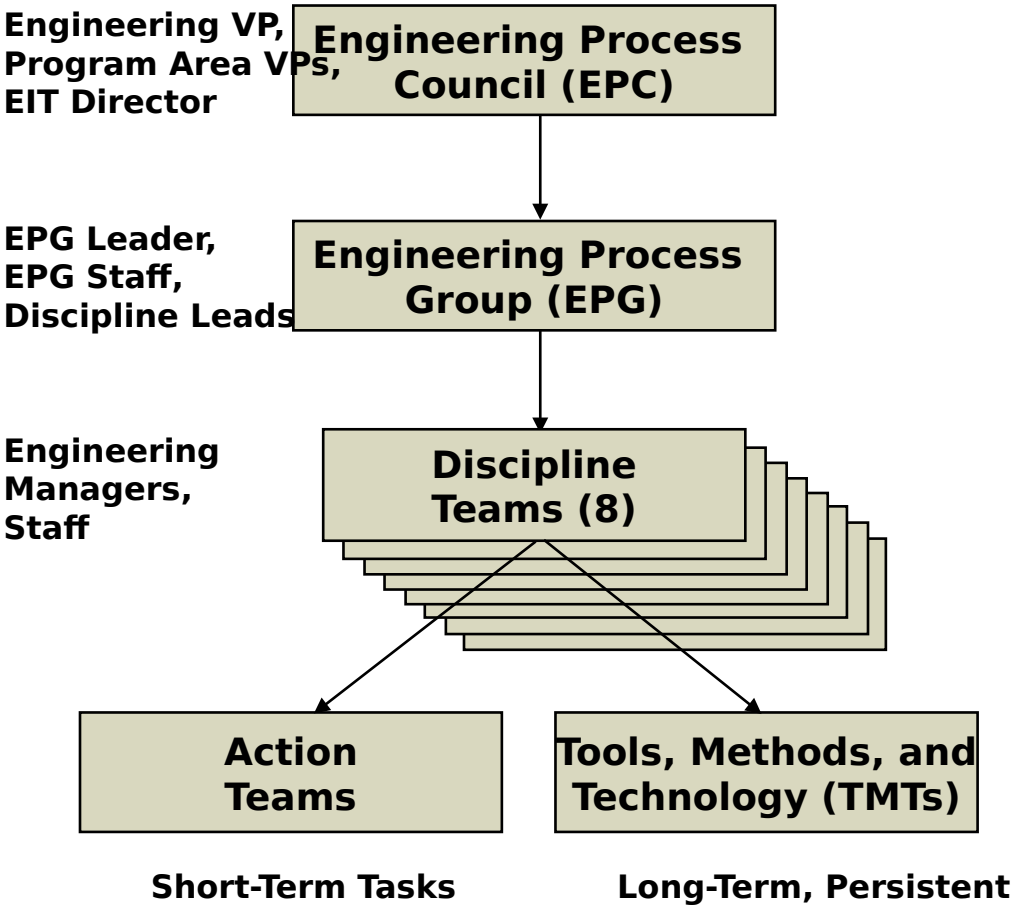
SYSTEM DEVELOPMENT & INTEGRATION



LOW POWER / MICRO-ELECTRONICS

- C^4I Systems
- Remote Operations
- Signal Intercept & Processing
- Exfiltration

Engineering Process Improvement



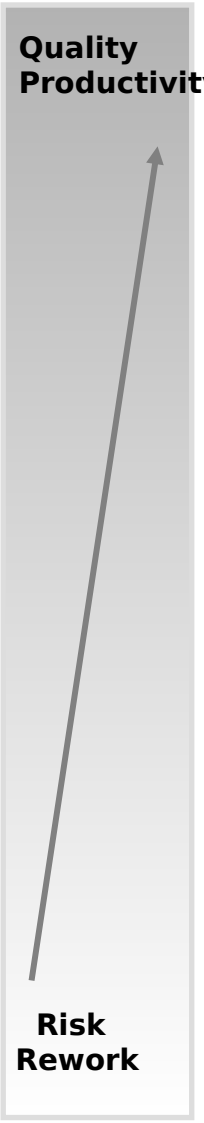
Executive Steering Group

Coordinate and Manage Cross-disciplinary Action Teams

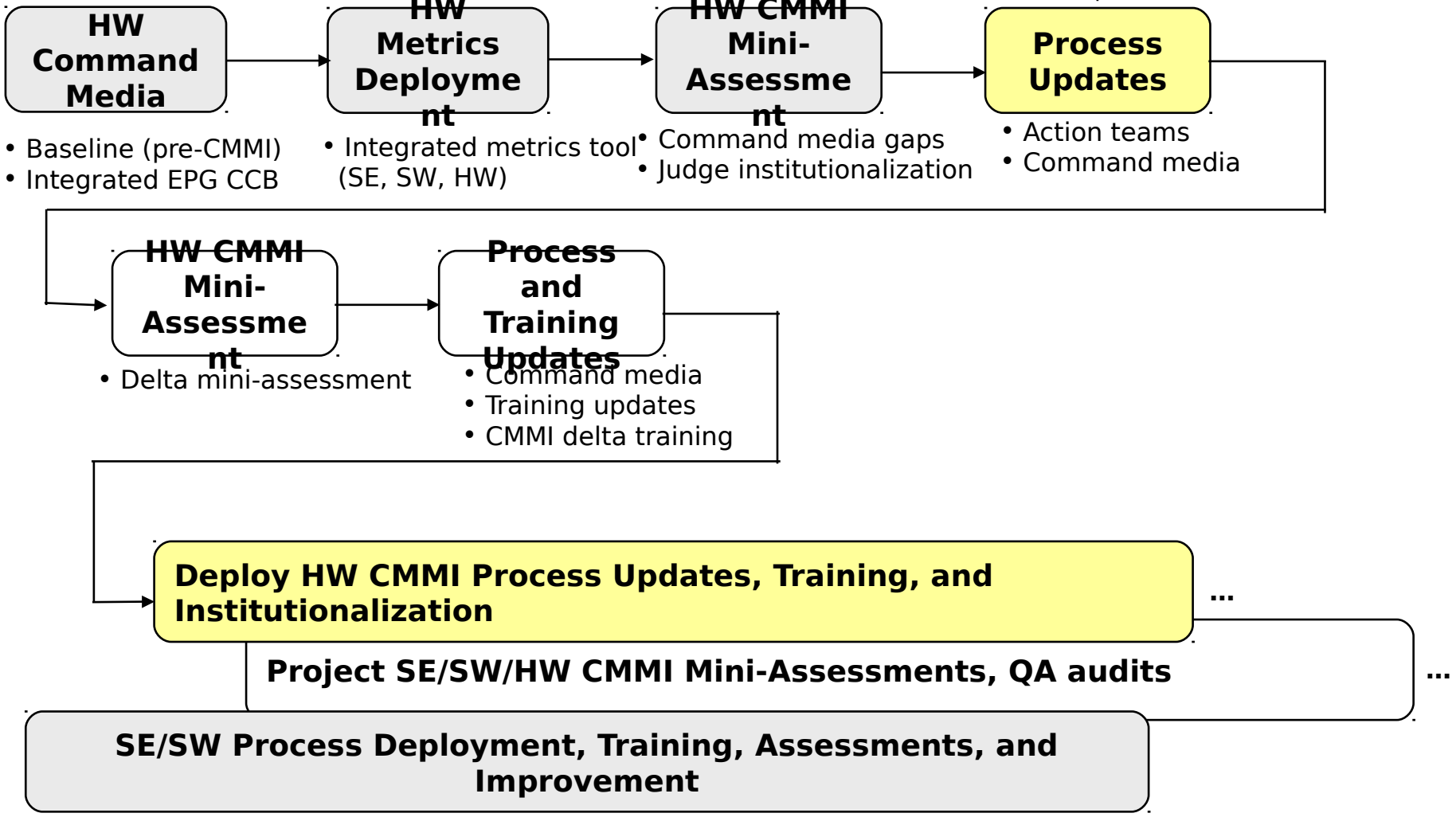
Systems Engineering
Software Engineering
Electrical Engineering
Mechanical Engineering
Antennas / RF / Optics
Integration & Test Engineering
Specialty / Support Engineering
Engineering Information Technology

CMMI Process Areas Staged

Maturity Level	Focus	Process Areas (PAs)
5 Optimizing	*Continuous Process Improvement*	Organizational Innovation and Deployment Causal Analysis and Resolution
4 Quantitatively Managed	*Quantitative Management*	Organizational Process Performance Quantitative Project Management
3 Defined	*Process Standardization*	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management Risk Management Decision Analysis and Resolution
2 Managed	*Basic Project Management*	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Initial		

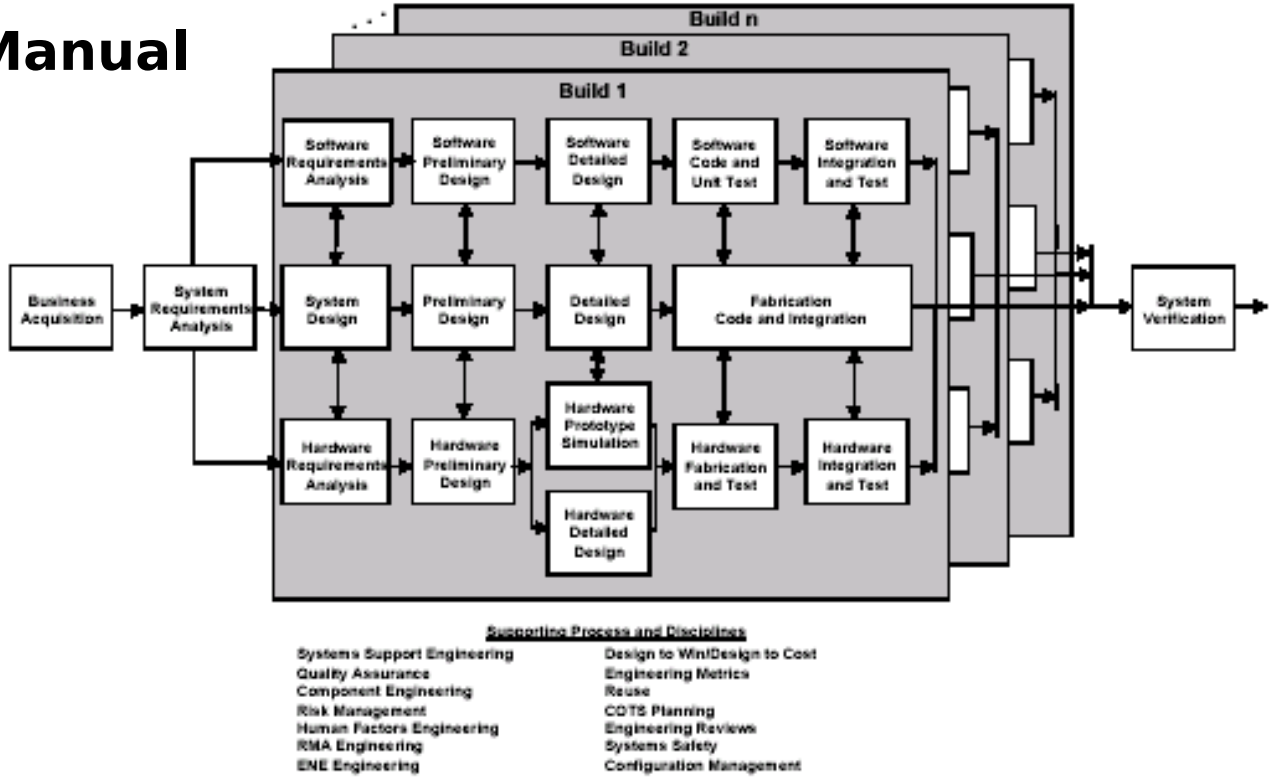


Hardware CMMI Action Plan



Division Standard Engineering Process

- **Policies**
- **Manuals**

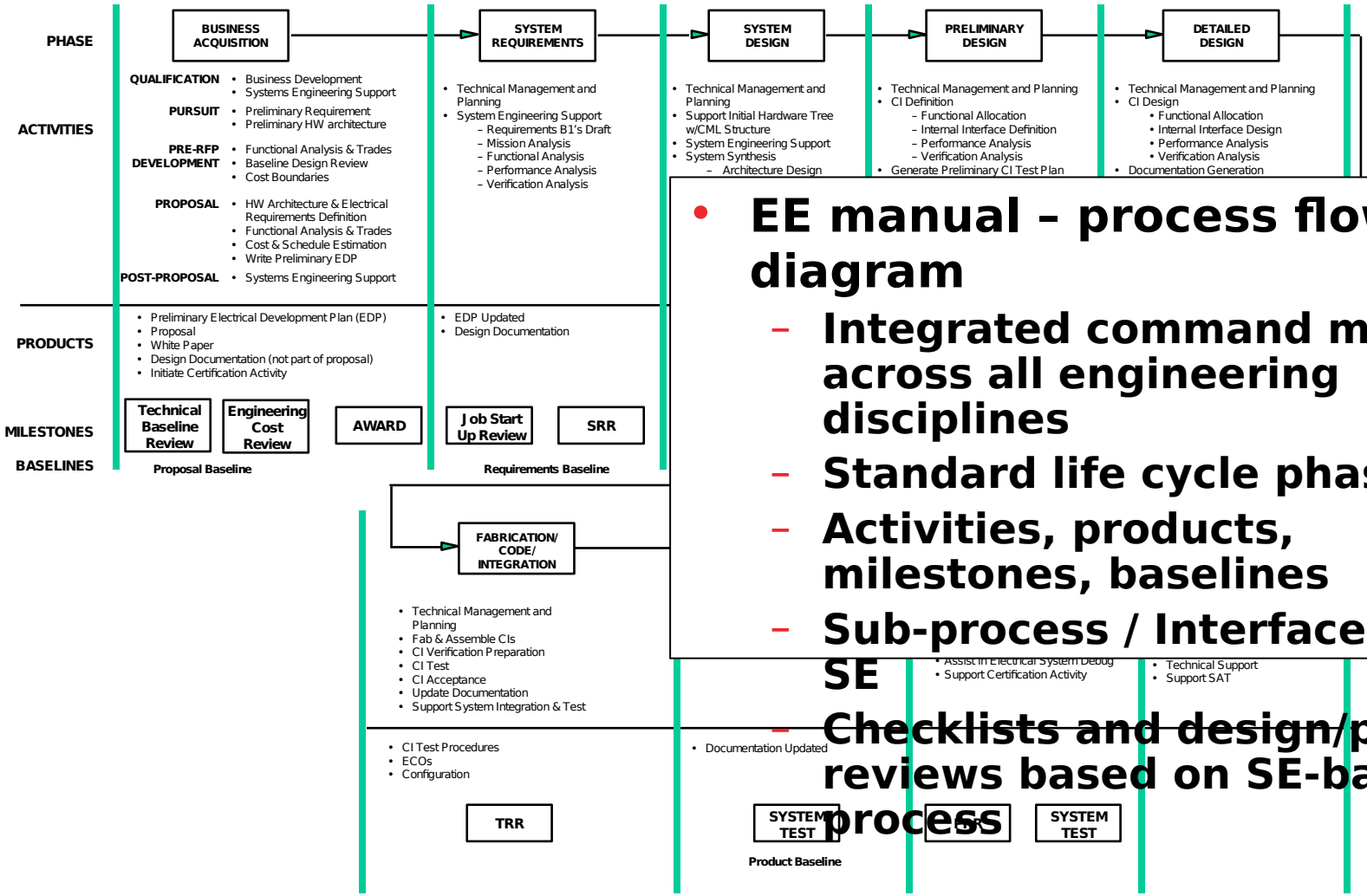


- **Handbooks (inter-disciplinary processes)**
- **Training (process and technical)**

Project Defined Processes

- **SEMP**
- **SDP**
- **EDP**
- **MDP**
- **Other plan**

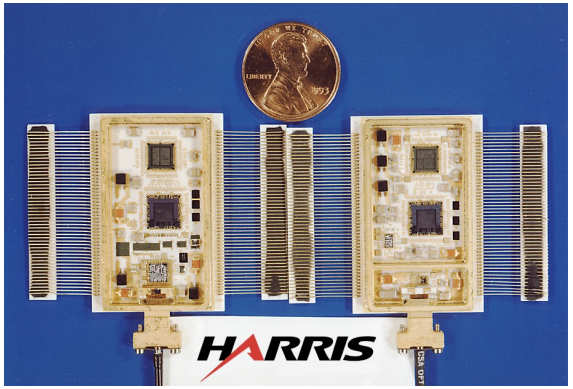
Electrical Engineering Process Overview



- **EE manual – process flow diagram**
  - **Integrated command media across all engineering disciplines**
  - **Standard life cycle phases**
  - **Activities, products, milestones, baselines**
  - **Sub-process / Interfaces with SE**
  - **Checklists and design/peer reviews based on SE-based process**

Hardware Improvement Objectives

- **Competitive bids**
  - **Productivity metrics**
  - **Labor metrics**
- **Predictive metrics**
  - **Predictable performance vs. plan**
- **Technological Capabilities**
  - **State of the art technology**
    - **Innovative project applications**
    - **Attract and retain creative talent**



These objectives drive how we plan and manage

Hardware Improvement Projects

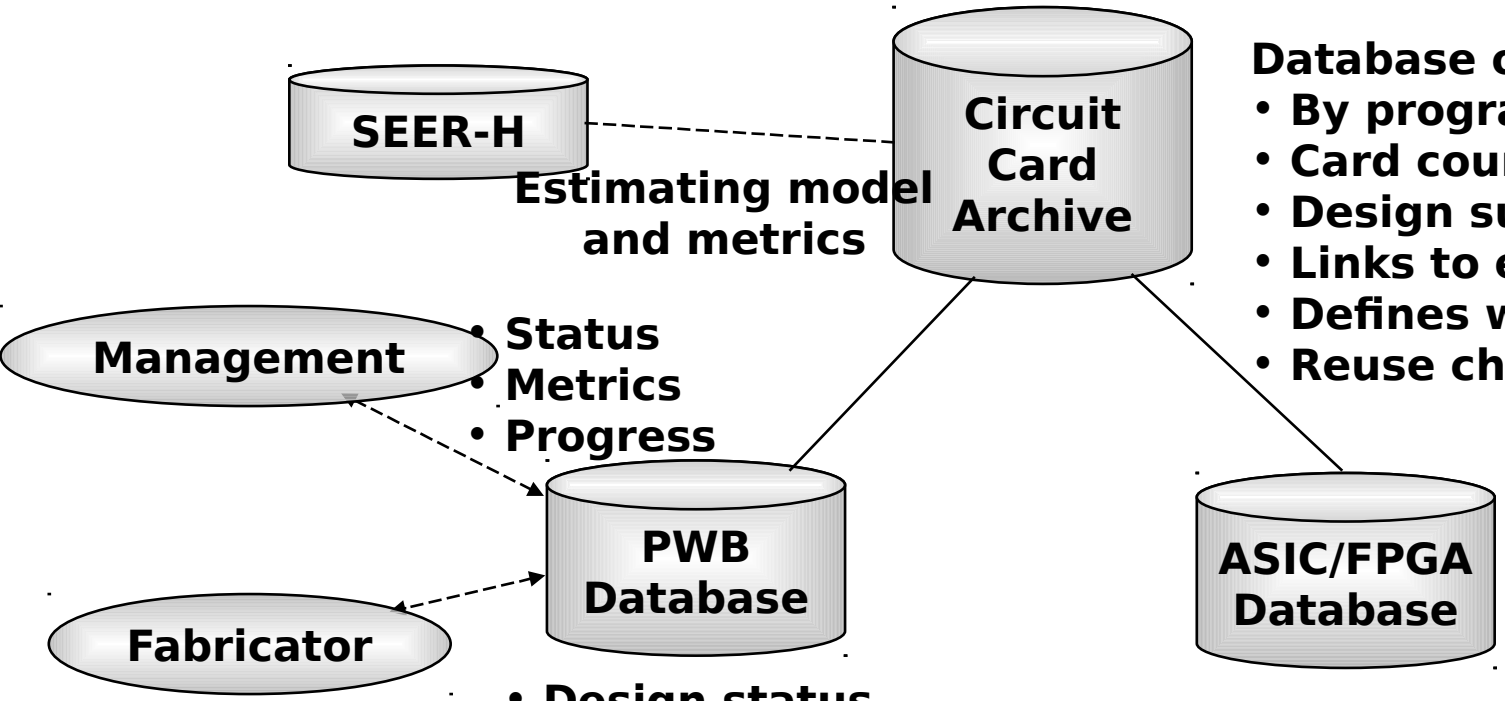
- **HW Tools, Methodology, and Technology (TMT) initiatives**
  - **Special projects (lessons learned)**
  - **Standardization of work products**
  - **Design archive (cost history)**
  - **Metrics database**
- **Benchmarking; tool evaluations; process reviews**
- **Technology roadmaps;**

- **Digital Engineering Technology areas (TMTs):**
- **ASIC/FPGA (advance semiconductors)**
- **Microsystems (microelectronics, MEMs, optics)**
- **Network systems**
- **Signal processing**

- **Metrics**
- **Productivity**
- **Qualitative information on designs (e.g. PWB metrics)**
  - **Circuit card archive**

- **Metrics are collected, analyzed, and used to track project hardware engineering progress, performance, and quality**
  - **Process characterization**
  - **Predictive metrics**
  - **Historical performance**
    - **Productivity**
    - **Cycle time**
  - **Technical performance (capability, TPMs)**
    - **Timing, sizing, link budgets, etc.**
    - **Emphasis varies by program and application**
  - **Engineering Cost Metrics Database (timecard charges)**

Hardware Historical Metrics



Hardware Estimating Process

Requirement

Establish The Requirement

WBS & Program Schedule

Requirements Document

Define the Scope of Work

- Block Diagram
- Material List
- Travel, ODC
- Subcontracts
- Capital & Facilities
- Design Process Map

Create A Bottom-Up Estimate

BOE Forms

Qualify The Bottom-Up Estimate

Compare against

- similar-to design
- productivity metric
- parametric tool as appropriate

- Metrics
- Design Archive
- Program Cost History

Design To Cost met?

NO

YES

Complete The BOE Form and Generate the Proposal Cost Review Summary

(Include costs from financial administrator)

BOE Forms

Proposal Cost Review Summary H-2472

Create a bid for each WBS element

Review Forms With Engineering Manager

Proposal Cost Review Summary Form(s)

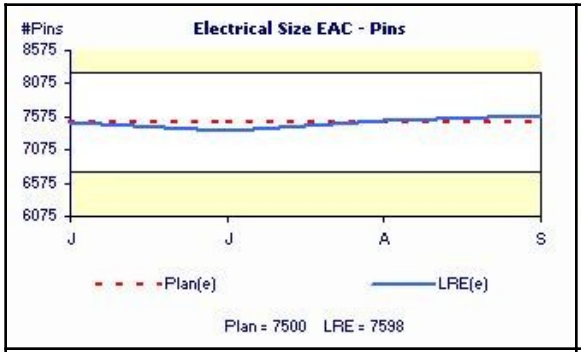
Proposal Cost Review

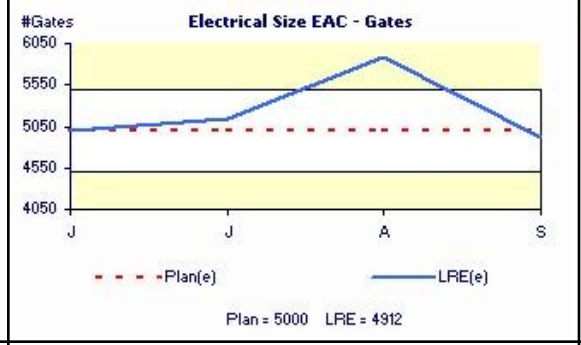
Electrical Engineering Performance

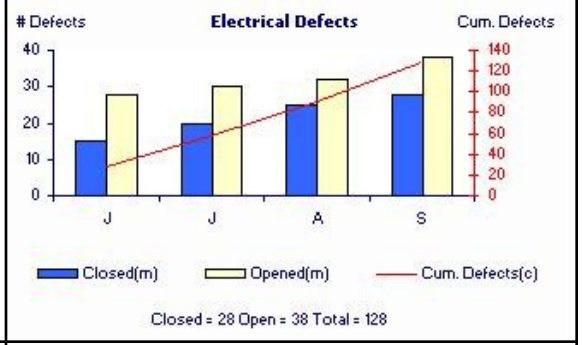
Proprietary Information – For Internal Division Reporting Only

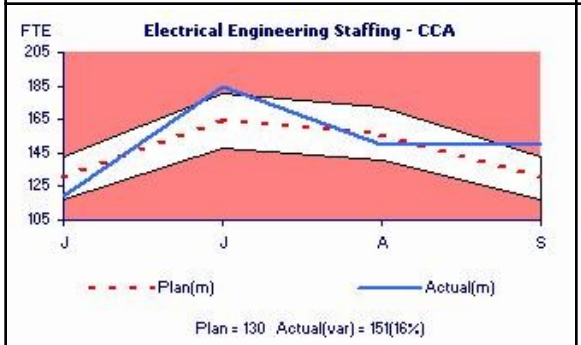
<ExampleProject>

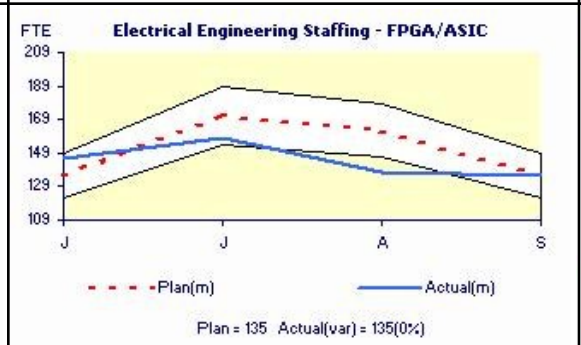
Reporting Period: September 1999 PEM

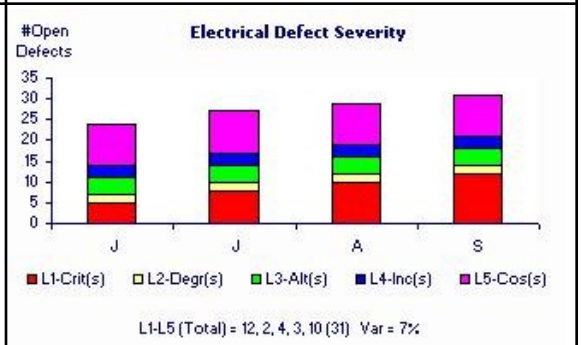










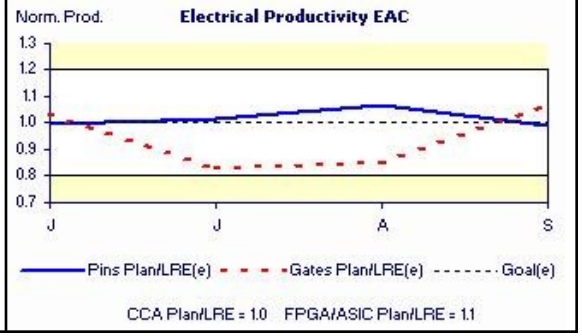


Electrical Engineering Pins Issues/Actions

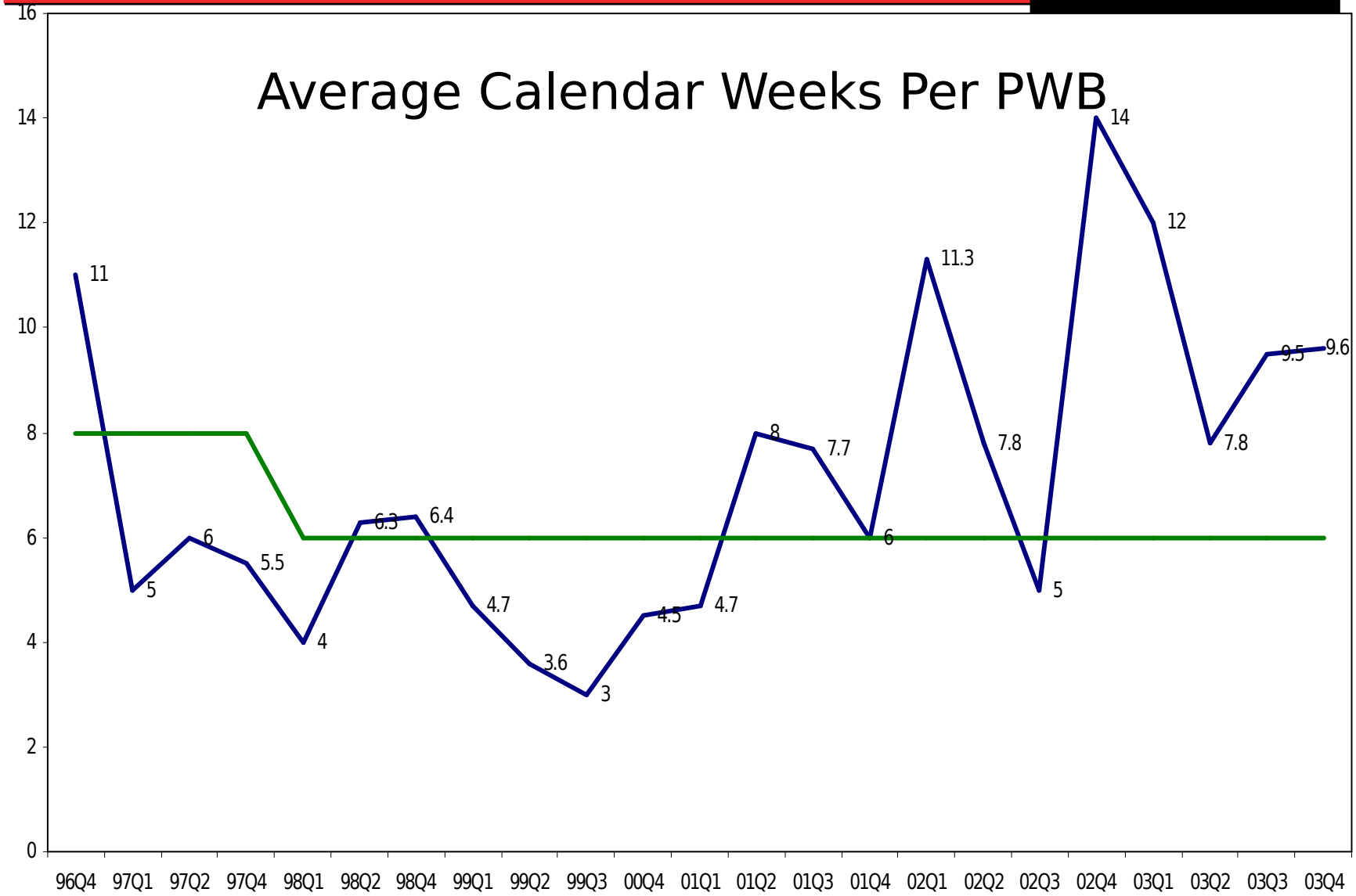
"Pins" issues/actions

Electrical Engineering Gates Issues/Actions

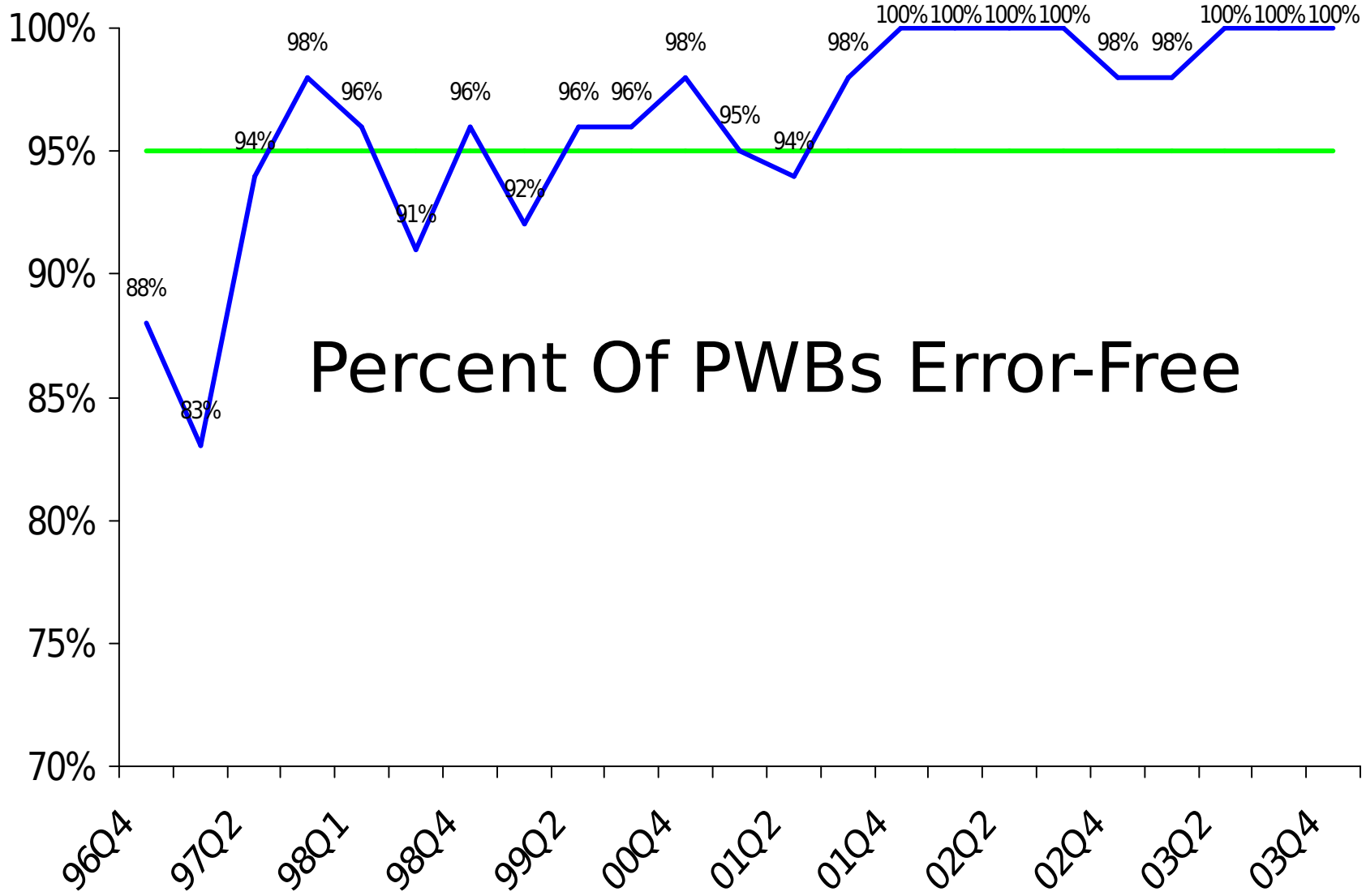
"Gates" issues/actions



Trending - PWB Cycle Time

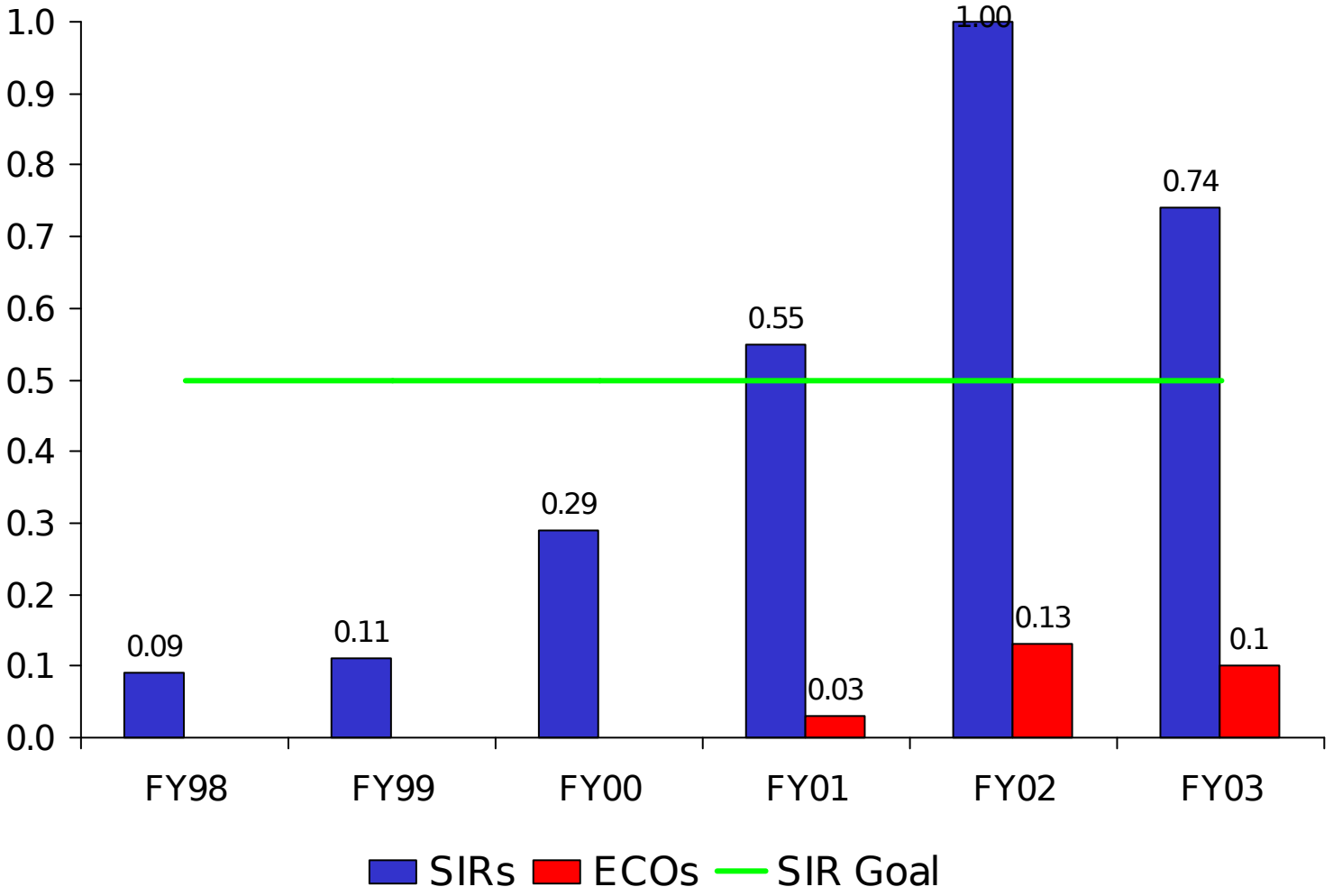


Trending - PWB Quality



Trending - PWB Defects Per Design

Number of ECOs and SIRs Per Design



Training

- **Customized employee training based on assigned role and gap analysis**
- **All PCB designers are IPC-certified**
- **Process training (design of circuit cards, FPGAs, MCMs, PWBs)**
- **Web-based tutorial**
- **New hire orientation**

- **Process compliance and product quality is assured by Engineering Management oversight and quality audits**
  - **Periodic audits of PWB vendors**
  - **Supplier summits**
  - **Defect metrics**
  - **Change requests**

Lessons Learned

- **Start a CMMI improvement project with a baseline assessment**
  - **Understand the model**
  - **Identify gaps**
  - **Implement the actions**
- **Ensure representation across projects and disciplines**
- **Metrics help define, characterize, and improve processes**
  - **Identify the prioritized areas for improvement**
  - **Start small, look for value**
  - **Use available data first before creating something new**

Contact Information

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